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GLACIATION IN THE ATLIN DISTRICT, BRITISH COLUMBIA.

IN the Atlin district of Northern British Columbia the topography east of the coast range is characterized by wide main valleys having a general elevation of a little over 2,000 feet above sea level; between these main valleys are groups of mountains separated by other wide but more elevated and sloping valleys.

Both of these valley systems show evidence of glacial action but both also appear to have been deep drainage channels before the advent of this glacial action, and, to have received since that period no great modification in their form.

The upper system of valleys, broad, flat and inclined at a moderate grade, look too big for the comparatively small and rapid streams which drain them. These streams moreover have only cut narrow gutters to no great depth below the general floor of these valleys.

In this district there is evidence of two glacial periods, a regional glaciation, and a local glaciation, in part, over the same ground, at a later time. There is also a present active and extensive local glaciation now going on in the coast ranges to the westward. The latter may be a survivor or remnant under more favorable conditions of the two former periods.

The earliest regional or Cordilleran glacier left its evidence upon the main valley floors, and upon the upper slopes of the highest mountain groups in the district, a difference of about 5,000 feet in altitude. The movement was in a northerly direction.

The later local glaciation may have been due to the action of a remnant of the regional glacier, but appears more likely to have been the result of a later dispersion from a local *névé*. This glaciation followed these upper valleys and slopes, leaving the upper mountain groups above their action.

Regional glaciation.—As evidence of the regional or Cordilleran glaciation may be taken the occurrence of foreign rounded boulders or erratics upon the upper slopes of the more or less isolated mountains of this district.

A light colored feldspathic granite and jasper are occasionally found at heights of over 4,000 feet above sea level, and 2,000 feet above the lower main valleys.

Mount Minto rises steeply from Atlin lake to a height of 4,700 feet above it, and 4,000 feet above the surrounding flats. The base of this mountain is hornblende-biotite granite, the upper portion of it is hornblende porphyrite; resting upon this porphyrite, near the peak, are rounded boulders of a light colored granite and jasper pebbles.

East of Teslin Lake, on the mountains above Ptarmigan Flats, there is a glaciated rock surface at a height of 5,490 feet above sea level, and about 3,000 feet above the floor of Teslin Valley, which is also glaciated.

Near this place there are boulders of a peculiar granite, having large crystals of hornblende. Such granite was only seen in place in the high, massive range six miles to the south and westward, across the deep intervening valley of Hurricane River, over 2,000 feet below these opposite ranges. If this valley existed at the time of boulder transportation, it appears to have had little directive power.

Local glaciation.—The local glaciation appears to have originated from the water shed between Atlin and Teslin lakes. This is a district of wide, upland valleys and arctic moors, for the most part above timber line.

Such local glaciers did not cap the mountain groups apparently, but filled in the depressions between them, acting as carriers and pulverizers of the local rocks only.

This glacial occupation seems to have been confined to these elevated flats and slopes, and the valleys leading down from them, in much the same way as with the present coast glaciers. At the present time these elevated valleys, which are sometimes over a mile wide, are largely covered with more or less assorted

gravels, boulder clay and morainic material, all of which is quite local in origin, the country rock being itself local and characteristic.

Elevated valleys.—The lower portions of Pine and Spruce creeks are terraced, the middle portions have false bedded material and boulder clay. The upper valley of Spruce Creek is covered with little hills of morainic material. Occasional boulders of rock, foreign to the present drainage basin, are attributed to the erratics of the regional glaciation. (See accompanying photograph.)

The streams now flowing through these valleys appear small in comparison with the wide troughs through which they run. Although rapid, and at times torrential, these streams have only cut narrow gutters into the drift and the rock floor beneath it. In doing this they have cut down to an older pre-glacial drainage and stream bed. The direction, grade and level of these pre-glacial stream gravels is very much the same as that of the present creeks, Pine and Spruce. These earlier gravels were traced, and apparently undisturbed, for two miles along Spruce Creek, lying directly beneath the mantle of gray blue glacial drift. They contain coarse gold. If it is assumed that coarse gold is concentrated by mechanical action in fairly rapid streams these gold bearing gravels should have been on the stream bed of a pre-glacial V-shaped valley, otherwise they would not have represented concentrations from the adjacent mountains, unless, like the present streams, they derived their gold and gravels from earlier stream or glacial deposits.

It appears probable that these pre-glacial gravels existed in the ordinary V-shaped troughs of mountain drainage originally, and that, local ice action, cleared out and widened the existing valleys without doing much towards deepening them. Such action appears to be borne out by a consideration of the existing glacier immediately to the south of Atlin Lake.

Llewellyn Glacier.—From the southern shores of Atlin Lake, flat-bottomed, fjord-like valleys lead up to tongues or lobes of the Llewellyn Glacier. These ice fronts are, in some cases, only

a few feet higher than the level of the lake, and a mile or so back from it. The intervening valley is flatly floored with quicksand or gravel, and is at times a mile wide at the ice front.

A rather small collection of morainic dumps lies in front of the ice. Swift glacial streams issue from beneath the ice front over beds of quicksand or gravel. These are heavily charged with sand and silt, but do not appear to bring out coarser material. These streams remove much of the coarse medial morainic material as it is gradually dumped over the ice front, and this may account for the small terminal moraines.

These medial moraines form wide low ridges of unassorted rock matter, stretching far back into the ice field, until they are lost to sight on the skyline or beneath fresh fallen snow.

The ice front rises very gradually backwards into the nearly level field of ice and snow, which continue south and westwards to Taku Inlet and the Pacific coast, a distance of 60 miles.

The upper surface of this ice field is about 5,000 feet above sea level, or 3,000 feet above Atlin Lake. Out of the general level of this inclined plain, mountain groups and peaks project, leaving wide, level gaps between them. Near the ice fronts the glacial surface is traversed by many small streams, which soon fall into crevasses. These probably supply most of the water which issues from the glacier front. Water action must be very slight within the interior region of the main glacier.

It appears that any loose material formed on the projecting mountain sides above the glacier will be removed. Frost and snow slides are very active agents in breaking up rock masses. The broken material finds no angle of rest. It falls between the ice and the shore and becomes a grinding agent, or else is borne out to feed the great medial moraines, hence it seems that this glacial action is very largely a widening one, continually trimming the sides of its directing walls, and acting as a carrier.

In such a way it may have widened out the water-worn troughs of the preglacial drainage, leaving at times portions of the deep stream bed unremoved.

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